

CORROSIVE ACTION OF THERMAL WATER ON THE WEBBING OF WATERBIRDS IN LAKES AROUND ROTORUA

By M. J. DANIEL

The curative properties of mineral waters the world over and of the thermal waters around Rotorua in particular, are well known. However the harmful effects of these hot to scalding acidic and alkaline waters on the vulnerable webbing of palmate birds does not seem to have been recorded before to my knowledge.

OBSERVATIONS

During a recent small study of Black-billed Gulls (*Larus bulleri*) nesting on thermal ground in the Whakarewarewa reserve (Daniel, 1963), it was noticed particularly on Lake Rotorua, that a significant number of Red-billed Gulls (*Larus novaehollandiae scopulinus*) had either no webbing at all or only webbing on one foot. Several surveys of the relatively tame red-billed gulls feeding on the lakefront revealed that as many as 20% of small flocks had lost some or all their webbing. Table 1 gives details of one survey taken in August 1963 of a flock of 30 gulls on the Rotorua lakefront.

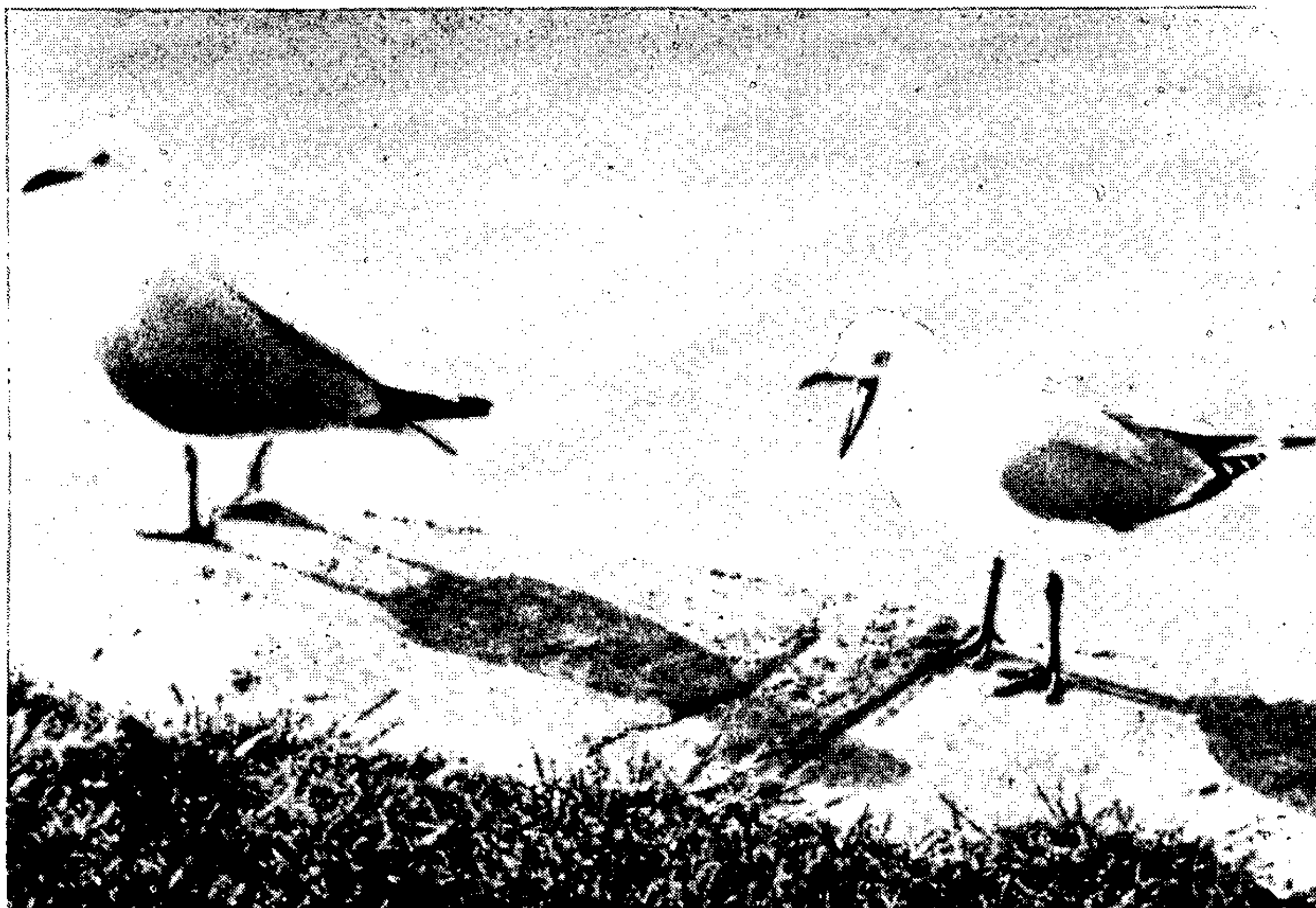
TABLE 1: Incidence of web damage in a flock of 30 red-billed gulls

<i>Species and age</i>	<i>Observation of feet</i>
1 adult gull.	No webs on either foot.
1 adult gull.	Web on one side of left, none on right
1 adult gull.	No webs or toes, only stumps.
1 juvenile gull.	No webs on either foot.
1 juvenile gull.	No webs on either foot.
1 juvenile gull.	None on left, normal on right.
24 adult & juvenile gulls.	Normal palmarion on both feet.

Total = 6/30, an incidence of 20%

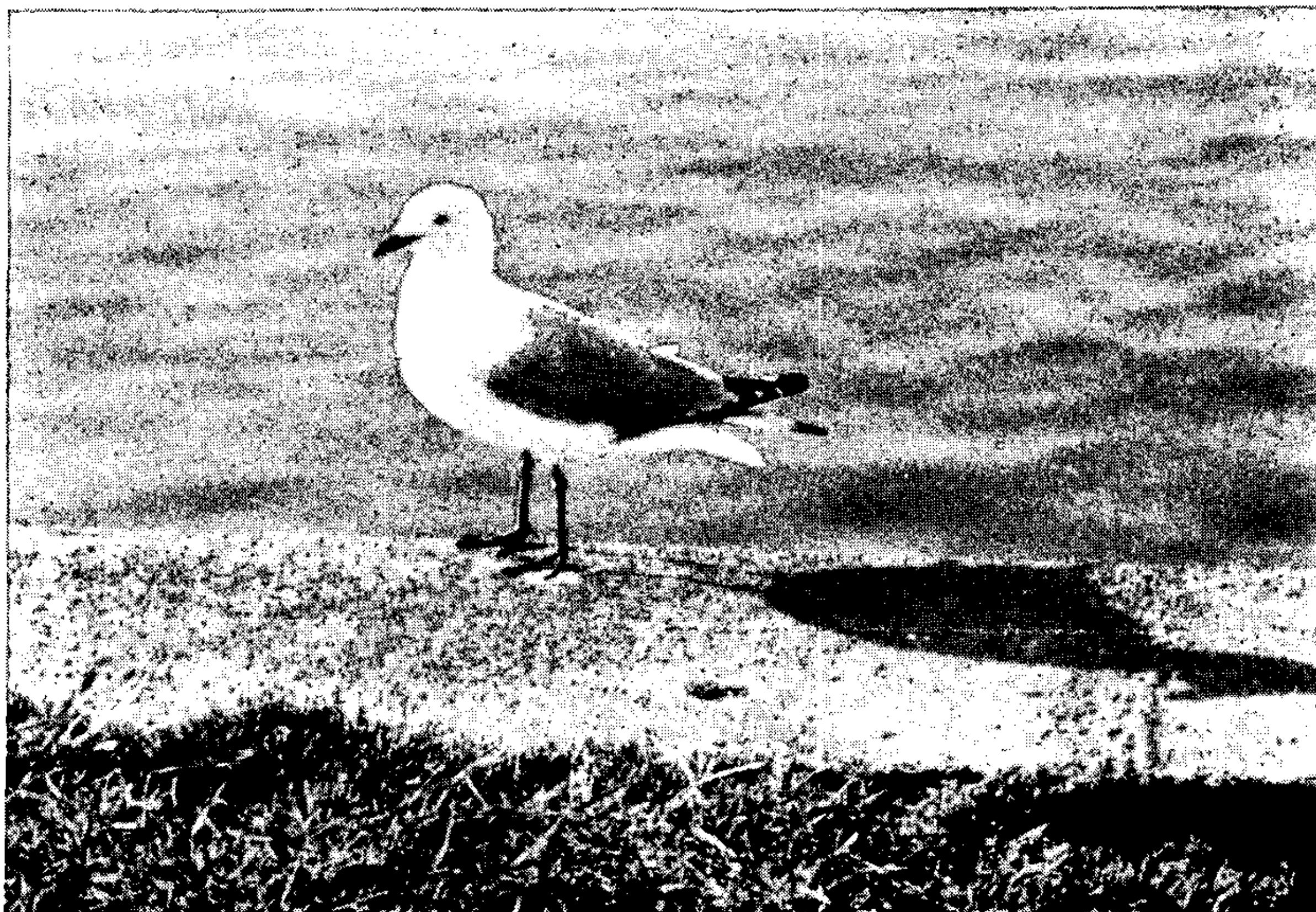
It can be seen from Table 1 that both adult and juvenile gulls were found affected. In one case, an adult gull as well as losing all its webbing, had also lost all its digits, leaving only two red stumps. Whether this small sample is representative of the several hundred gulls of three species nesting at Sulphur Point on Lake Rotorua (Black, 1955), is not known. Plates 1 and 2 show some of these affected gulls. These observations were taken at very close range, less than five yards. At ranges greater than this it was difficult to see the details of the palmarion, particularly when the bird was flying. This may explain why this phenomenon has not been recorded before to my knowledge. Several attempts were made to examine the webbing of the gulls at Sulphur Point with a telescope, but it was found that the details could not be determined.

This corrosive action on webbing is not confined to gulls however. Field Officer A. G. Hall of the Wildlife Branch informed me that he had observed it in Mallards, Scaup and in Black Swans on Lake Rotomahana. He found in a sample of 20 swans that 15 or 75% had one or more of their webs missing. Again it is not known if this is a real sample of the estimated 5000 swans on this lake, a wildlife refuge.



[M. J. Daniel

XLVII (a) — The adult Red-billed Gull on the right has no webs on the left foot but both on the right foot. The other gull is normal. Lake Rotorua.



[M. J. Daniel

XLVII (b) — Adult Red-billed Gull with no webs on either foot. Lake Rotorua.

A checklist of the birds recorded around the thermal lakes on the volcanic plateau kindly supplied by Mr. Max Black, reveals that there are at least 15 species of palmate birds. These include 3 species of gulls, 4 species of shags, 6 species of ducks and one species each of terns and swans. It would be interesting to find out whether more than the 4 species recorded in this preliminary study have been found affected by the corrosive water.

METHODS

Besides direct observation at close range of the 3 species of gulls, water samples were taken at several sites and analysed for temperature, hydrogen ion concentration (pH value), chloride and sulphate ion concentrations.

RESULTS AND DISCUSSION

There can be little doubt that the relatively thin and insensitive skin of the webbing of these palmate species has been literally "eaten away" by either the acidic or alkaline waters of the hot lakes in this region.

According to Grange (1937) in his bulletin on the composition and temperature of all the lakes and springs in the thermal region around Rotorua, the various springs, lakelets and lakes vary markedly in their acidic and alkaline properties, mineral content and amount of total dissolved solids. Even one small lakelet can vary from strongly acidic to alkaline within only a few yards. An example of this is in Roto-a-Tamaheke, where the Black-billed Gull study was done. Where the water is boiling it is alkaline ($\text{pH} = 8.3$), but a few yards away in the turbid shallow area it is highly acidic ($\text{pH} = 3.2$). The temperatures also vary greatly from about 158 degrees Fahr. to 208 degrees Fahr.

Grange (*op. cit*) states that the acidity of the lakes and springs is due to free sulphuric and hydrochloric acids and to a lesser extent to aluminium sulphate, while the alkalinity is caused by the alkali carbonates and to a lesser extent to borates and silicates.

Some water samples collected in Lake Rotorua in open water near the Sulphur Point gull colony give hydrogen ion concentrations as acidic as 3.0 (the pH varied from 3.2 to 3.0). The chloride ion values for these same sites varied from 49.5 to 56.5 ppm and the sulphate values varied from 148 to 172 ppm. The water temperature varied from 18 to 20 degrees Centigrade (64 to 68 degrees Fahr.). Samples taken from Roto-a-Tamaheke in the Whakarewarewa thermal reserve, gave a pH range of highly acidic ($\text{pH} = 3.2$), to alkaline ($\text{pH} = 8.4$). The chloride range was from 594 to 763 ppm and the sulphate from 95 to 295 ppm.

Since gulls' feet were not available to test how quickly this corrosion effect might be taking place, a stag's head complete with antlers was lowered into a hot pool at Whakarewarewa with a pH of 8.4 (thus alkaline not acidic), and a temperature of 208 degrees Fahr. After 24 hours of immersion it was found that both the skull and the antlers were completely decalcified and crumbled away in the fingers. This was dramatic proof of the speed of the corrosive action in not a highly acidic pool but an alkaline one.

This demonstration shows that for palmate species swimming in lakes like Rotorua or Rotomahana which have "hot spots" and which are highly acidic or alkaline, it would be quite possible for them to lose their webbing, probably without any pain, since their feet are

notoriously insensitive to high and low temperatures. An example of this is the fact that gulls stand, sometimes on one foot, on the hot steam pipes behind the Queen Elizabeth Hospital on the Lakefront. These pipes are far too hot to touch with the hand. At the other end of the temperature scale, I have seen several species of ducks, particularly the four species of eiders and the Long-tailed Duck, standing for hours on ice and perma-frosted ground in the north of Alaska waiting for a lead to open up in the sea ice. However in the literature available to me I was unable to find any reference to work done on the lack of feeling in the feet of palmate species.

It seems probable that the corrosive action of these acidic and alkaline thermal waters is enhanced both by the high water temperatures in some areas of the lakes and by the buffering chemical action caused by the high concentrations of dissolved salts and solids.

Besides the one adult red-billed gull observed without any digits (Table 1), several gulls of this species have been seen with only one leg. At first it was assumed that either opossum traps or vandalism by children was the cause of this, but after the antler demonstration it might be the more dramatic and serious effect of the corrosive water.

In a discussion by Wodzicki and Robertson (1959) on the effects of volcanic activity on the birdlife of White Island, they mention that the red-billed gulls nesting at Crater Bay have had their plumage corroded away leaving only the bare shafts, giving the birds the appearance of being in full moult. They conclude that this is due to the action of acid water in both the acid stream and Crater Bay in which the gulls frequently bathe. It is surprising that no effects were noticed among the gannets, apart from the "bluish haze" which hangs over the gannetries caused by the hydrochloric acid in the air acting on the ammonia in the excrement on the ground, forming ammonium chloride. Surely here if anywhere you would expect to find corrosion of the feet of palmate species.

No plumage damage due to thermal water has been observed on this study of the gulls on the Rotorua lakes. This could possibly be because the acidity of the water where the gulls feed is not as high as that experienced off White Island.

The effect of the loss of some or all of the webbing to a palmate species is probably quite severe. It was observed that the gulls with no webbing at all had some difficulty in getting off the water and off dry land. It would also presumably markedly effect their powers of swimming and feeding, particularly in species like the ducks and the Black Swan. It would be interesting to learn whether similar corrosive effects on palmate species have been observed and recorded in the thermal regions of Italy, Iceland and California.

ACKNOWLEDGMENTS

I am indebted to Mr. Max Black, Mr. Peter Bull and Dr. Kaj Westerskov for comment and to Mr. N. H. Cummins and Mr. R. Glover for the pH, chloride and sulphate determinations.

LITERATURE CITED

- Black, M. S., 1955 — Some notes on the Black-billed Gull at Lake Rotorua. *Notornis* 6, 6:167-170.
Daniel, M. J., 1963 — Observations on chick mortality in a colony of Black-billed Gull in the thermal area at Whakarewarewa. *Notornis* 10, 6:277-289.
Grange, L. I., 1937 — The Geology of the Rotorua-Taupo Subdivision. *Bulletin No. 37*, Geological Survey D.S.I.R. 1-138.
Wodzicki, K. A., and Robertson, F. H., 1959 — The Birds of White Island, in *D.S.I.R. Bulletin* 127, compiled by W. M. Hamilton and I. L. Baumgart.